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Report NAVTRAEQUIPCEN 78-C-0182-4

FUNCTIONAL REQUIREMENT
FOR
AIR INTERCEPT CONTROLLER
PROTOTYPE TRAINING SYSTEM

Robin Halley, Michael R. King and
Elaine C. Regelson
Logicon, Inc.
Tactical & Training Systems Division
Post Office Box 80158
San Diego, California   92138

April 1982

Final Report for Period 28 September 1978 –
28 June 1981

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This report presents the Functional Requirement for development of the experimental prototype Air Intercept Controller Training System. Training requirements are discussed in establishing preliminary definitions of hardware and software which will support an automated adaptive training system which incorporates advanced computer speech recognition and generation.

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FOREWORD

This is the fourth in a series of reports leading to the design, implementation, and test of the use of computer speech recognition technology in the tactical training area. The complexity of the system will require a special effort to insure communication between psychologists, training analysts, computer scientists, and fleet personnel.

This report provides a description, in language oriented to Fleet personnel, of the training requirements for the AIC. This report serves, in addition, as a bridge between the behavioral objectives and the system design. Thus, this is the final review prior to the systems engineer's beginning actual design of the overall system.

Thanks are extended to the command and staff of the Fleet Combat Training Center, Pacific. The continuing efforts of CDR Souder, LCDR J. Millican, OSCS J. Billups, OSC J. Lindsay, all of Code 31, and Mr. Charlie Spencer of Code 98A, have been invaluable.

R. BREAUX, Ph.D.
Scientific Officer

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INTRODUCTION

BACKGROUND

The training package (ACE) of the experimental prototype air intercept controller training system will provide basic training to students to enable them to control air intercepts and training setups using simulated Naval Tactical Data System (NTDS) equipment. Moreover, the system will be used as a research tool to study applications of automated speech technology and effectiveness of automated instructional methods in military training systems.

There are four basic goals for the training system. The first goal is the most pragmatic. That is, to provide the required synthetics training to enable students to control live aircraft under supervision of an instructor.

The other three goals are research and experimentation oriented. The first research goal is to study the usefulness of automated speech technologies in military training. These technologies include computer generated speech, computer speech recognition, and computer speech recording and playback. Research in this area is very important in respect to training for jobs such as air intercept control where personnel are responsible for transmitting, receiving, and responding to verbal messages.

The second research goal is to study the applicability and effectiveness of instructional methods using automated, adaptive performance-based instruction. That means that this project will be researching how well an automated instructor can measure a learner's performance by providing instruction customized to the learner's problems.

The product of the final research goal will be a specification for an operational trainer and an expression of the lessons learned during the development of this project. The system development documentation of an assortment of effectiveness tests will provide data for the project goal to provide suggestions and recommendations for the construction and development by the Navy of an operational air intercept controller and anti-submarine air controller training system.

ACE HISTORICAL PERSPECTIVE

The development of the ACE training structure has been approached using instructional system design (ISD) principles as a basis. The ISD structure in Figure 1 indicates a fairly definite order in which to proceed.

The task analysis for this project revealed differences of opinion between what Air Intercept Controller (AIC) training "should" do to be most effective and current training practice. The most important difference is one of orientation. The learner presently is trained primarily to master the equipment for "controlling" aircrew training. The orientation preferred by the sources consulted for the task analysis is one that teaches the learner (1) to identify the information the aircrew needs for understanding tion. The difference between the two orientations is between teaching the
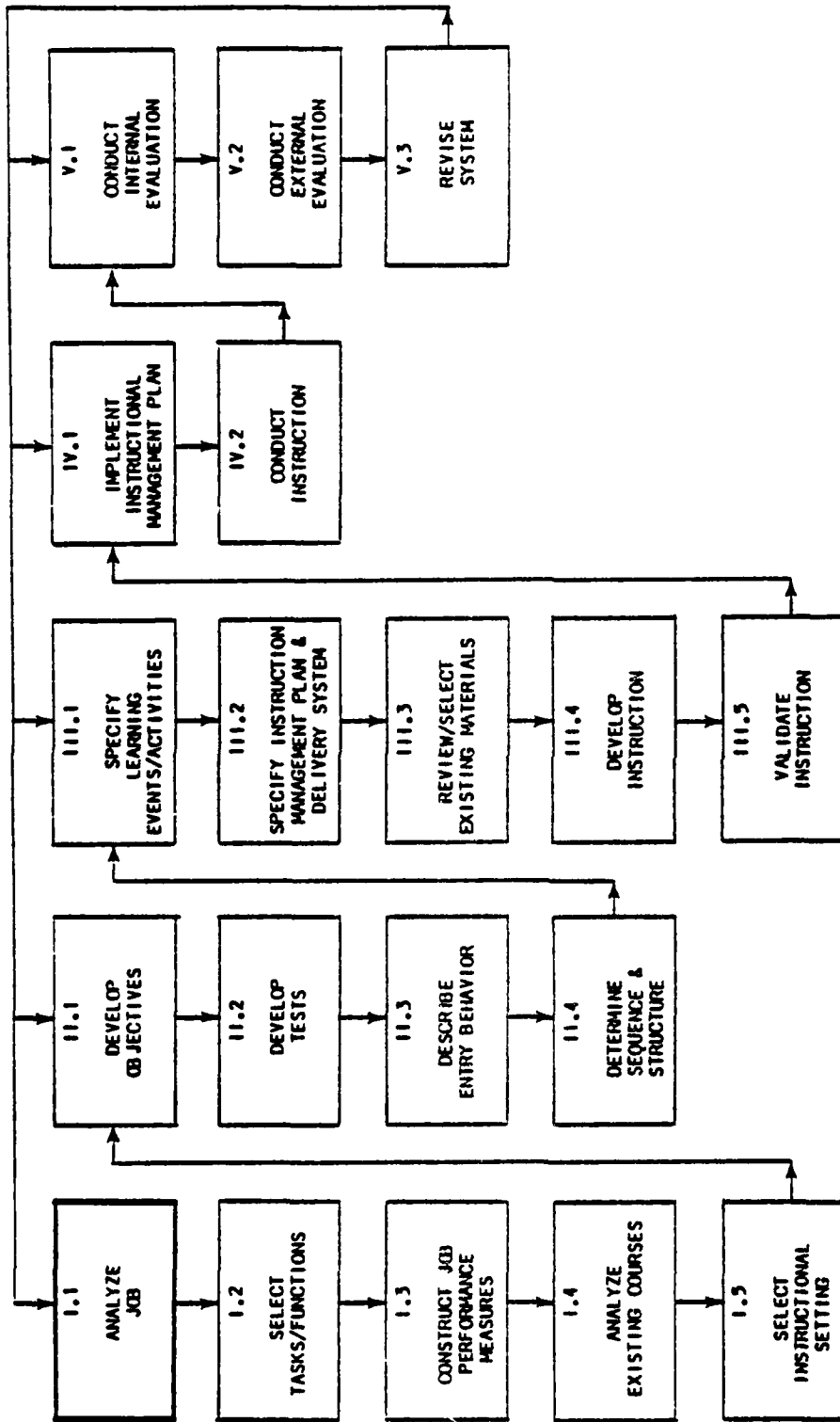
5

Figure 1. Instructional Systems Development (ISD) Flow Diagram.[1]

1. Interservice Procedures for Instructional Systems Development, Phase I Analyze; U.S. Army Transportation School, Fort Eustis, Virginia; Page 1, Block I.1; 1 August 1975.

the tactical environment and (2) the ways the AIC can obtain that information. The difference between the two orientations is between teaching the learner (1) to control the training environment and (2) to support the tactical environment.

BEHAVIORAL OBJECTIVES. The products of the job (task) analysis were (1) a description of the AIC mission and work environment and (2) a model of the processes involved in the AIC's job (Behavioral Objectives Report[1]). The modelled processes involved in the job were next further divided into lower level behaviors. The result was a task flow diagram and a behavioral objectives hierarchy of the AIC's job, stated in measurable, observable behaviors with accompanying conditions and standards for each behavior. These behaviors were aimed toward use in instructional contexts, so sometimes behaviors which would not other wise be measurable were "artificially" named as such:

      1.3.2.2.1 MATCH PRESENT CHARACTERISTICS WITH DEFINING CHARACTERISTICS FOR ADDITIONAL HOSTILE AIRCRAFT

      2.1.1.1   LIST THE TYPES OF DATA WHICH NEED TO BE UPDATED

With these conditions, behaviors, and standards delineated, a successful performance of a job task can be identified by observation of the learner doing the task and comparing the outcome with the listed behavioral standard.

SYLLABUS. The next development step was that of designing the general learning sequence, to be presented in the syllabus. In order to identify what to teach trainees in this AIC basic course, there are a couple steps that precede the actual design of the syllabus. First, it must be determined what the learners will be able to do at the start of the course. For this course the prerequisites are graduation from the NTDS users school and six months operational experience using an NTDS console.

      An exact identification of these prerequisites, in terms of student entry level skills within the context of AIC basic tasks, has never been done. Thus, the development of a performance based pretest, which is based on the minimum required skill levels, will enable us to identify candidates who possess the skills acceptable for entry into the course.

      The next step preceding the development of the syllabus is the identification of the minimum acceptable skills required to (1) do the basic job in a tactical environment and (2) control live aircraft in a training environment under supervision of an instructor. Many of the basic skills are used in both the tactical and training environment, but both environments also require unique skills. Identifying the skills required for graduation from the synthetics portion of AIC basic school was based on a process where skills critical to job success were delineated. These are identified as

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1. Behavioral Objectives for Air Intercept Controller Prototype Training System; Report NAVTRAEQUIPCEN 78-C-0182-1 (Logcion, Inc.). Naval Training Equipment Center, Orlando, Florida; September 1981.

Category A Tasks in Appendix A of the Ordinal Syllabus Report.[2] Other non-critical skills to be addressed in the instruction are identified as Category B tasks.

Identifying the end of course skill levels for each task behavior was the next step. From these end of course standards post-test scenarios were developed to test (1) tactical environment skills and (2) training environment skills. With the beginning and ending skill levels defined, the next step was to identify the order in which to present the instruction to the learner and guide him successfully from start to finish. That process and its results are presented in the Ordinal Syllabus Report. A further list of the basic training topics grouped in terms of must know, need to know, and important to know are attached here as Appendix A. These training topics are related to the behaviors shown in Appendices B-E of the Objectives Hierarchy Report.[3]

Thus, at this point, the behavioral objectives for the task of training basic air intercept controller skills have been identified, analyzed, and organized in the Behavioral Objectives Report and Objectives Hierarchy Report. A student training course has been established by the Ordinal Syllabus Report. It is now necessary to define what functional requirements the system must have to support the training approach required by the project goals and represented in the structure of the syllabus.

PURPOSE

This document is a Functional Requirements Report. It describes in functional terms how AIC training will be accomplished by the experimental prototype training system. It discusses the training requirements of the system and the basic training functions which will be supported. It will be used as the basis for the functional design of the system which will be detailed in the Functional Design Report[4] and Prototype Configuration Report.[5]

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2. Ordinal Syllabus for Air Intercept Controller Prototype Training System; Report NAVTRAEQUIPCEN 78-C-0182-3 (Logicon, Inc.). Naval Training Equipment Center, Orlando, Florida; September 1981.

3. Objectives Hierarchy for Air Intercept Controller Prototype Training System; Report NAVTRAEQUIPCEN 78-C-0182-2 (Logicon, Inc.). Naval Training Equipment Center, Orlando, Florida; December 1981.

4. Functional Design for Air Intercept Controller Prototype Training System, Report NAVTRAEQUIPCEN 78-C-0182-8 (Logicon, Inc.). Naval Training Equipment Center, Orlando, Florida; December 1981.

5. Prototype Configuration Report for Air Intercept Controller Prototype Training System, Report NAVTRAEQUIPCEN 78-C-0182-6 (Logicon, Inc.). Naval Training Equipment Center, Orlando, Florida; in press.

SECTION II

TRAINING REQUIREMENTS

The purpose of this section is to identify the training requirements associated with the training system. These training requirements are identified in the context of the planned console configuration as well as the training approach and instructor model being implemented.

TRAINING SYSTEM

The training system is made up of three distinctly different functional groups: (1) hardware, (2) software, and (3) courseware. The process of development is one of constant definition and redefinition of resources, capabilities, and constraints, interactively between the groups. Changes made by any of the groups ultimately will affect each of the other two groups.

TRAINING SYSTEM COMPONENTS. The training system is made up of three main components: (1) the Student Station, (2) the Instructor Station, and (3) the computer system. The Student Station will provide instructional materials: (1) from an instructional area where materials presentation is done using audiovisual (A/V), computer terminal, and automated speech and (2) from a Training Enhancement Console (TEC) where the AIC NTDS console and Air Control (AC) mode controls are simulated.

The Instructor Station will include a computer terminal and a hardcopy printer. There the instructor can monitor the student's progress through reports on the CRT, request hardcopy printouts for evaluation of the student or system, and input appropriate changes to the student's training sequence.

The computer and speech hardware supporting the training are discussed in detail in the System Requirements section.

TRAINING APPROACH. In order to meet the diverse goals of this project, a complex and well designed training approach is needed.

Training Structure. This system's basic concept of AIC training is a mastery level approach. Within this approach the learner is first taught the most basic and/or most essential skills. After mastering these skills, the learner slowly adds additional complex skills until, at the end of the course, he can perform all the skills at the required levels.

The mastery level approach is hierarchical or building block in nature. The various groupings of subjects have been given titles to indicate the different divisions of courseware. The term "courseware" includes all test, A/V, and simulation instruction directing the learner along a predefined instructional sequence. The following definitions help to identify each division and provide a base for subsequent discussion of the training system

LEVEL: A level is the first division of courseware. This breakout identifies the major subject areas to be addressed at that level. Examples of this are "LEVEL 3, Simple Air Intercept Control" and "LEVEL 5, Multiple Friendly Aircraft."

UNIT: A unit is the second division of courseware. This division identifies cohesive blocks of instruction to be addressed within a level. Examples of this are "LEVEL 3, UNIT 4, On Station" and "LEVEL 5, UNIT 1, Using IFF to Identify Friendly Aircraft."

LESSON: A lesson is the third division of the courseware. This division identifies yet smaller blocks of instruction which are all logically related. Examples of materials addressed within a lesson are "LEVEL 3, UNIT 4, LESSON 1, Arriving on Station" and "LEVEL 5, UNIT 1, LESSON 2, Locating and Identifying Aircraft Using IFF."

SEGMENT: A segment is the fourth division of courseware. For this training system a lesson sequence may be made up of 1 to 3 segments. These types of segments are Interactive Teaching, Commented Practice, and Free Practice. Each segment may have an associated post-test. The learner must pass the post-test before the automated instructor will allow advancement to the next segment.

Types of Instruction. Down to the segment level, the above named divisions of the courseware are mostly definition of subject matter. The segment level is concerned more with defining the types of learning and the appropriate instructional content for those types of learning.

All of the instructional segments for the AIC basic course have been defined as falling into one of three categories: (1) interactive teaching (IAT), (2) commented practice (CP), and (3) free practice (FP). Interactive teaching segments are those which require the learner to read text, look at examples on the AV presentation system or the TSC at the simulation station, or exercise skills and give voice calls in direct response to computer prompting. IAT segments will be where the learner will encounter new material. In this type of segment, the learner will likely be learning memory items such as definitions of transmission vocabulary, what constitutes priority information in a given situation, or the proper procedures associated with some skills.

After the trainee has been introduced to tasks, rules, procedures, and definitions or has done some memorization of vocabulary in an IAT segment, he can apply that learning in a CP segment. CP provides the learner with a problem or a control scenario and has him practice the newly acquired skills in a very controlled - but more realistic - environment. When the learner makes a critical error or a certain number of a specific type of error, the automated instructor will stop the proceedings to provide feedback (comments) concerning the errors and make appropriate suggestions about ways to correct the errors.

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In FP segments the learner integrates what has been mastered in preceding interactive teaching, commented practice, or, sometimes, free practice segments. These segments are different from commented practice because the learner gets no explicit feedback until the end of the practice and because these scenarios may possibly involve use of every skill the learner has mastered up to the present point in the syllabus.

Integrated Instruction. There are two concerns to be met in the area of integrating instruction. First, it is important to design pieces of instruction which are small enough for the learner to master but large enough to keep the instruction from being too simple and boring. Second, there must be a careful process of grouping the new skills together and adding those groups of new skills to skills which have been previously mastered.

The first problem is dealt with in ACE by teaching the skills for a particular situation in a carefully designed series of related IAT and CP segments. The second concern is handled by a graduated integration of the newly acquired skills with previously learned skills in FP segments. A sequence of instructional segments at the end of a level might look like this:

IAT - CP - IAT - CP - CP - FP - IAT - CP - IAT - CP - FP - FP - FP

In this sequence four topics are taught in two lessons. The extra CP is a segment integrating the two previous topics. The two extra FP segments are the integrating segments for the unit and level materials. Graduated practices with complex or involved materials help to ensure successful practice for the learner. This, in turn, helps to keep up the learner's motivation.

Identifying Success/Failure. This training approach is based on criterion-referenced competency-based instructional design. In order for the learner to progress through the syllabus, he must show successful completion of prescribed tasks. How success and failure are identified in this training system is discussed below.

Criterion-referenced instruction requires that measurable, observable success criteria (standards) must be established. In this way the learner's performance can be observed and a judgment can be made as to whether the standard for success has been met. In ACE, the automated instructor will be responsible for measuring learner performance. The particular methods being used for measurement of performance in this instruction vary according to the types of instruction.

In interactive teaching segments, the instruction will be focusing on concepts and procedures. Performance will be measured in relatively traditional ways, i.e., through direct questioning via the computer terminal (true/false, multiple choice, et.al.) or by simple interactions at the TEC.

In commented practice (CP) and free practice (FP) segments, the instruction will be focusing on applying the concepts and skills (presented in the IAT segments) within an operational-like environment. Performance will be measured here through the use of a Performance Measurement Subsystem

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(PMS), aided by a Model Controller. Each instructional topic will have one or more Performance Measurement Variables (PMVs) associated with it.

In the ACE training system there are situations wherein a number of PMVs are involved. For example, the learner may have to give position and velocity calls on the bogey, respond to SWC orders, give friendly reports, and determine state and status. In a situation like this, two types of standards can be used. First, there can be a standard for successful completion of each performance behavior (a range and bearing call each sweep with x miles and y degrees of accuracy), and there also can be a standard which indicates successful completion of the entire scenario (e.g., no more than three PMVs failed). Using both of these types of standards allows the automated instructor to pay attention to the learner's overall performance and to the specific learner weaknesses. As a result, more adequate feedback and error messages can be generated to help the learner, and more precise prescriptions of remediative work can be made. Diagnosis and prescription will be discussed in more detail later in this report.

INSTRUCTOR MODEL (DEALING WITH SUCCESS/FAILURE). It is important to carefully define what is done as the result of success or failure. A discussion follows of the ways a learner may progress through the course and the actions that may take place as a result of this success or failure.

Success. Success results in progress from segment to segment (intersegment advancement) and progress within a segment (intrasegment advancement).

Figure 2 provides a simplified diagram of the automated instructor model for intersegment advancement. Using this model, the learner starts by advancing in the syllabus to the next interaction with the learning system. Each interaction has an associated set of performance standards. At the end of each segment of instruction, the learner's performance is compared to the criterion standards established for advancing past that segment. If the learner meets or exceeds the standards for that segment, he is advanced to the next segment.

If the learner does not meet the criterion standards, his scores are reviewed by the adaptive scheduling software which will compare the performance measurement results to predicted problems to identify a specific remediation. If the specific problem cannot be identified, general remediation is addressed. If an appropriate remediation pathway is available and has not been previously presented to the learner, the automated instructor will prescribe it, and the learner will re-enter a learning interaction with the system, continuing the loop until he meets criterion or is exited from the system. If the learner has already been through all the remediation choices and still is not meeting criterion standards, he will be exited from the system to the human instructor. The instructor can, at this point, make a training decision whether (1) to personally provide still more remediation, (2) to skip past this segment despite the learner not meeting criterion standards, or (3) to remove the learner from training.

The learner also must advance through the internal elements of each instructional segment. Some of this advancement is under learner control, and some is under automated instructor control, depending on the type of learning involved. Figure 3 provides simplified diagrams of the instructor models for intrasegment advancement, described in following paragraphs.

ENTER

LEARNER
ADVANCES
IN SYLLABUS

INTERACTION
WITH LEARNING
SYSTEM

ADDRESS
REMEDIATION

COMPARE LEARNING
TO CRITERION
STANDARDS

MEETS
STANDARDS

DOES NOT MEET
STANDARDS

PRESCRIBE
REMEDIATIVE
ACTIVITY

HAS LEARNER
EXHAUSTED
REMEDIATION
OPTIONS?

NO

YES

EXIT TO INSTRUCTOR
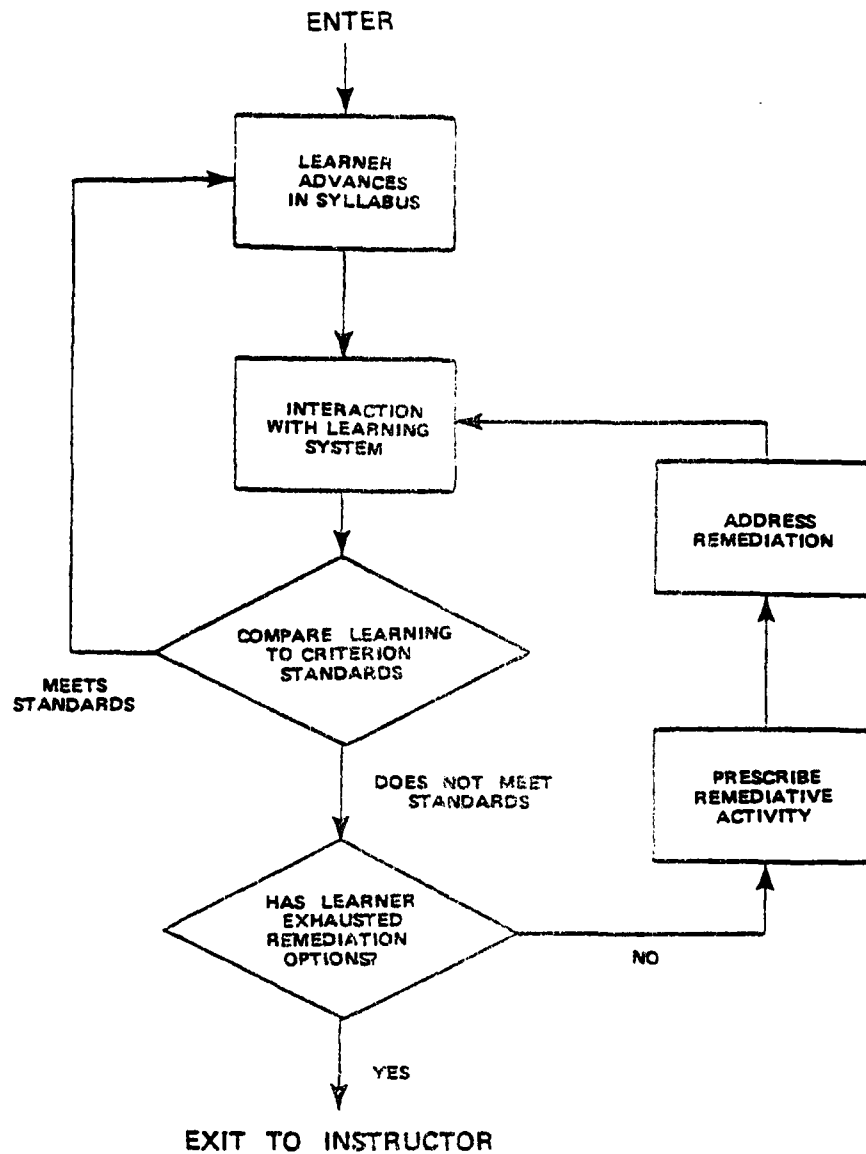
Figure 2.   Automated Instructor Model for Intersegment Advancement

MODEL 1
INTERACTIVE TEACHING SEGMENTS

```
┌──────────┐     ┌──────────┐     ┌──────────────┐     ┌──────────┐
│ EXPECTED │     │          │     │ ILLUSTRATION │     │ PRACTICE │
│ LEARNER  │ ──▶ │GENERALITY│ ──▶ │ OF GENERALITY│ ──▶ │  (TEST)  │
│ OUTCOME  │     │          │     │              │     │          │
└──────────┘     └──────────┘     └──────────────┘     └──────────┘
```

```
                                     ┌──────────────┐
                          NO         │     DOES     │
   ┌──────────────┐  ◀──────────     │  PERFORMANCE │
   │ REMEDIATION* │                  │ MEET CRITERION│
   └──────────────┘                  │   STANDARD   │
                                     │      ?       │
                                     └──────────────┘
       * CAN INCLUDE FEEDBACK AND ADDITIONAL    │ YES
         PRACTICE (TEST) AS REMEDIATION         │
                                            ┌─────────┐
                                            │ ADVANCE │
                                            └─────────┘
```
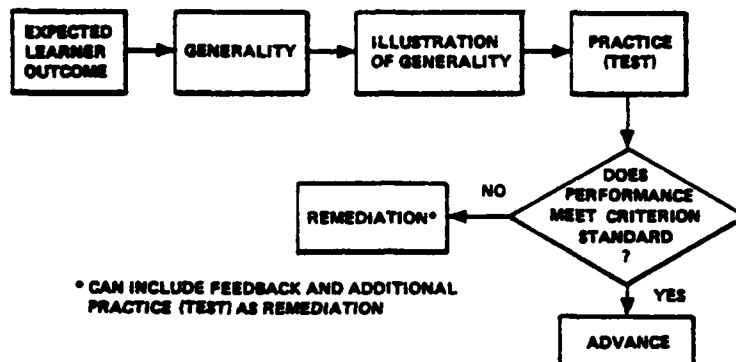
MODEL 2
PRACTICE APPLICATION SEGMENTS
(COMMENTED AND FREE PRACTICE)

```
┌──────────────┐     ┌──────────┐
│ INTRODUCTION │     │          │
│    (ELO)     │ ──▶ │ PRACTICE │
└──────────────┘     └──────────┘
```

```
                                                    ┌─────────────┐
                                          YES        │ REMEDIATION │
   ┌──────────────┐        ┌──────────┐ ──────────▶ └─────────────┘
   │   COMPARE    │  FAIL  │   MEET   │     NO
   │   SCORE TO   │ ─────▶ │ MAX FAIL │ ─────
   │  CRITERION   │        │ CRITERION│
   │  STANDARD    │        │    ?     │
   └──────────────┘        └──────────┘
                                          ┌──────────┐
          PASS                            │   MEET   │     NO
          ─────────────────────────────▶ │ ADVANCE  │ ─────
                                          │ CRITERION│
                                          │    ?     │
                                          └──────────┘
                                               │ YES      ┌─────────┐
                                               └────────▶ │ ADVANCE │
                                                          └─────────┘
```
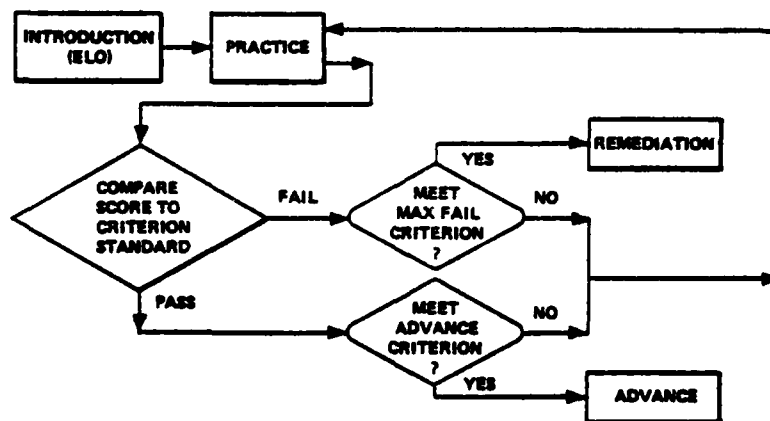
Figure 3.   Automated Instructor Intrasegment Advancement Models

Model 1 shows components of an interactive teaching segment. The learner proceeds through the components (by advancing to new pages of text and answering questions) at his own pace.

Before the learner enters the instruction, he is presented an expected learner outcome (ELO) statement which tells him what he will have to do to pass this segment. The first component is the generality. A generality is a brief presentation of the core material to be learned. This could be a description of a procedure or rule, a fact to be memorized, or the definition of an important term.

The next component is the illustration of the generality. This component presents the generality in use. This is important for the learner to see the application of the generality in context. Helps for the illustration also may be provided. Finally, the learner is provided the opportunity to exercise or practice the new skills just presented, in a highly structured environment. This component culminates in a performance test, the results of which are used as previously discussed.

Model 2 applies to advancement through practice applications segments (commented practice and free practice). In this model the learner has less control than in Model 1. Here, again, the learner instruction begins with an introduction to the expected learner outcome (ELO) of the segment. Next, the learner is told how he may pass or fail the segment.

At the end of the practice, the learner's scores are compared to the established criterion standards. If the learner passes the standard for the practice, the advancement software then checks to see if he has met the standard for advancing out of the segment. If the learner has met this standard the advancement software schedules the next segment. If the learner has not met this standard he starts another practice scenario. If the learner fails the standard for the practice, the advancement software checks to determine if the learner has failed the maximum allowable number of times. If he has, the learner is channeled into appropriate remediation. Otherwise, the learner starts another practice scenario.

Diagnosis. Just as the advancement models must have options for learner success, they must also consider learner failure and the consequences of failure. When the learner fails, a three step process in invoked. Diagnosis is the first step in dealing with instructional failure. Just as a doctor diagnoses a specific illness from a set of symptoms, a carefully planned instructional system can identify a specific learning weakness from a particular set of mistakes. To help predict the relationship between weaknesses and mistakes, an indepth common error analysis (CEA) has been done. A common error analysis identifies the important mistakes learners most commonly make, the reasons the errors are made, and the results of the error. From this information, the PMS can be designed to look for the common errors as a way of knowing what instructional weaknesses need to be addressed.

Prescription. The second step in the process of dealing with learner failure is prescription. Depending on the learner's previous remediation on this topic, the mistakes he has made, and the weakness that may have been diagnosed, the automated instructor will prescribe some specific action by

the learner to correct the failure situation. It is impossible to predict all the kinds of errors a learner can make; so, on occasion, the learner may be given a general prescription (e.g., "see instructor") rather than a specific prescription (e.g., "do segment X").

Remediation. The third step in dealing with learner failure is remediation. In ACE, remediation will be both general and specific. General remediation is incorporated into the feedback given to the learner within CP segments or at the end of FP segments. Specific remediation will depend on the segment type and the learning problem. In those cases when general remediation is considered inadequate, any of several specific remediative choices may be available: special components within an IAT segment, repetition of the same segment or previous segment, execution of special remediative IAT or CP segment, etc. It is unlikely that all instructional segments will have multiple remediative paths, or that any one segment will have all types of remediation available. The human instructor will always be the final remediative choice.

TRAINEE FEEDBACK. One problem relating to the construction of a successful training system is that of maintaining learner motivation. The learner must be able to perceive how the instruction is going to meet his needs; and, once into the instruction, the learner needs to know how he is doing and what he can do to do better.

The training system provides both kinds of motivational feedback to the learner. As the learner enters an instructional sequence, he is told exactly what behaviors he will be asked to do for that instruction (expected learner outcome) in terms of measurable, observable performance. At the end of each run, the learner will be provided with feedback concerning both strength and weaknesses on the criterion standards for the segment in which he is presently involved. At the end of each segment, the learner will be provided a reward message noting his success. Also, indepth hardcopy print-outs will be available from the instructor's station detailing the quality of trainee performance in the segment and/or his performance in previous segments. Examples of Trainee Feedback are shown in Figures 4 and 5.

AUTOMATED SPEECH

The training system will utilize three different aspects of automated speech technology:

a. speech recognition

b. computer voice generation

c. digitized speech recording and playback

A brief discussion of the purposes and uses of those automated speech functions within the training design follows.

SPEECH RECOGNITION. Speech recognition involves the capability of the training system to understand specific words and phrases used by the trainee during the course of instruction. This understanding will allow the performance measurement subsystem to determine if the utterance is the correct one

DETAILED SEGMENT SUMMARY REPORT

PATH NO: 31
STUDENT NAME: BUSH, MIKE

SEGMENT ID: 2.09 IAT Heading To Station
ENTRY MODE: NORMAL   DATE: 03/11/81   TIME IN: 09:37
EXIT MODE: NORMAL   TIME SPENT: 0:08:38
INSTRUCTOR CALLED: NO CALL

TEST/CHECK ID   PASS/FAIL   TEST_RESULT/CHECK_ERROR

  TEST 1556   PASS   75%
  TEST 1557   PASS   100%

Figure 4.   Student Evaluation Report

DETAILED SEGMENT SUMMARY REPORT

PATH NO: 33
STUDENT NAME: BUSH. MIKE

SEGMENT ID: 2.07 CP Heading/Bearing And Range To Station
ENTRY MODE: NORMAL   DATE: 03/11/81   TIME IN: 10:39
EXIT MODE: REMED   TIME SPENT: 0:10:53
INSTRUCTOR CALLED: NO CALL   MIN/MAX NO OF RUNS: 3/10

RUN NO. 1   REASON RUN TERMINATED: ERROR FREEZE

PMV/F   PASSING_SCORE   SCORE   PASS/FAIL   ACTION
  4   95   94   FAIL   FEEDBACK

RUN NO. 2   REASON RUN TERMINATED: ERROR FREEZE

PMV/F   PASSING_SCORE   SCORE   PASS/FAIL   ACTION
  3   100   80   FAIL   FEEDBACK

RUN NO. 3   REASON RUN TERMINATED: ERROR FREEZE

PMV/F   PASSING_SCORE   SCORE   PASS/FAIL   ACTION
  3   100   65   FAIL   REMEDIATION

Figure 5. Student Feedback

for the situation and will allow the pilots and/or SWC models to provide a simulated response to the utterance. With these capabilities ACE can provide a much higher fidelity training environment than has been possible heretofore for AIC synthetics training.

There are still, however, very severe limitations on the capability of automated systems to recognize spoken phrases. These limitations include the amount of allowable variability in the speaker's voice, a limited recognition capability in terms of number of phrases or words, the inability to recognize connected speech (long strings of words), and the requirement to train the system to recognize each word or phrase uttered by each speaker. This project is designed to examine the current state-of-the-art of automated speech recognition technology and design it into a training system to see (1) how the recognition capability enhances training and (2) what new technological innovations can be designed to enhance speech recognition in training. In particular, this project will utilize a connected speech recognition capability with respect to headings, bearings, and other numerical information. This limited connected speech recognition (LCSR) will be combined with isolated word or phrase recognition (IWR) to meet the requirements of ACE. The Nippon Electric Company (NEC) DP-100 is a commercially available unit which provides LCSR for a limited vocabulary. The output of this device will be enhanced with automated speech recognition techniques to meet the requirements of ACE.

To accomplish automated speech recognition in AIC training, four different processes have been designed in. First, specific introductory and training materials are provided at the outset of the curriculum to collect voice reference patterns and to build learner confidence in the ability of the system to recognize and understand him. Second, speech validation processes are designed in to check that what was collected in the voice reference patterns is being understood. Third, a limited capability is provided for retraining the system on specific words and phrases when misrecognition or nonrecognition for words or phrases becomes apparent. Fourth, system understanding will be augmented through a priori knowledge of the "state-of-the-world," and this information will bias the selection of potential outputs from the speech recognition logic.

DIGITIZED SPEECH. The training system provides the capability for both recording and playback of digitized speech. Recording and playback capability are used for replay of student work during training scenarios. The replays can be used both as a check on the system's capability to correctly recognize and score learner transmissions and performance, and as a feedback mode for displaying student performance. Digitized speech playback may be used during instruction as an additional voice source to support Votrax and the audiovisual presentation system and to provide the voices for the Ship Weapons Coordinator (SWC) and pseudo bogey models.

COMPUTER GENERATED SPEECH. The training system can generate speech through the use of Votrax speech generation equipment. The computer generated speech will be used during training to provide the voices for the ACE system and the CAP model.

Studies of previous uses of computer generated speech in training systems has suggested problems with learner understanding and learner accept-

ance of the computer's "voice". The ACE training design is taking those
potential problems into consideration. The problem of learner acceptance
appears to be based on learner perception of the computer as a machine.
This system will attempt to minimize this problem by presenting the system
voice as a personality called "ACE" (e.g., "Hi, I'm ACE controller, your
instructor and guide for this course"). The problem of learner understand-
ing will be positively addressed during the same training used for speech
recognition. That training will have the learner working on understanding
"ACE" while the system is working on understanding the learner.

PARAMETERS

A discussion of system parameters necessary to support the basic
training functions follows:

TRAINING ENHANCEMENT CONSOLE. ACE will provide a training console which
will be similar in appearance to a UYA-4/V-10 console using NTDS program
Model 4.0.1. The IFF equipment will simulate the UPA-59A. ACE will provide
simulation for NTDS console functions, NTDS symbology, and radar. The por-
tions of the AC mode of the NTDS Operational Program necessary to support
the syllabus also will be simulated. Appendix B presents examples of pro-
posed designs for TEC Panel layouts.

The following NTDS console functions will be simulated.

a. The quick action buttons for the AC mode

b. The number entry controls and display

c. Required displays in the data readouts (DROs)

d. The fixed action buttons including drop track, enter mode and
radar, radar select, enter offset, intensity controls and range
scale selection from 16, 32 and 64 miles

e. The track ball and controls for the ball tab

f. One radio channel and controls

g. Three intercommunications channels and controls

h. A plotting scope which rotates to compensate for magentic
variation

NTDS symbology simulaton will include the following capabilities:

a. Up to twelve total air symbols including friendly, CAP, hostile,
and unknown air symbols, with speed leaders and assignment and
engagement bars as appropriate

b. Balltab, hook, TACAN station, ownship, geometry lines between
symbols, a fly-to-point capabilty, and a command tracking function

c. The plan position indicator readout (PPIRO) which displays information on the scope of the track in close control. (For example, range and bearing information will appear by an engaged track.)

The following radar functions will be simulated:

a. Radar sweep including:

1. bloom and controlled decay of background and video

2. sweep speed of five per minute

3. adjustable intensity of both sweep and video

4. track fades

5. range mark display

b. A maximum of twelve videos, with a selectable size of small, medium and large

TACTICAL REQUIREMENTS. ACE will simulate tactical and aircrew training scenarios of varying levels of difficulty, to train the student to respond to differing aircrew mission environments. A capability to define and modify the scenarios will be provided to support courseware development.

MISCELLANEOUS SYSTEM DATA. System functions not addressed elsewhere are addressed below.

Aircraft Models. ACE will simulate aircraft (used in exercising trainee controlling skills) on the trainee's TEC display. The simulated aircraft will use standard F-4 values for rates of turn, acceleration/deceleration, and climb/descent. The aircraft models will respond to the tactical situation and to directives from the scenario definition parameters.

Personnel Models. ACE will simulate the various people surrounding the AIC trainee's world. ACE will provide a pilot model for the CAP. The CAP pilot model will respond to trainee commands with voice and appropriate action.

ACE also will provide a tracker model and a SWC model. The tracker model will update the symbols of all aircraft with the exception of the CAP. The SWC model will emulate the Ship Weapons Coordinator's role in liaison with the AIC during tactical aircraft missions.

The Votrax equipment will be used to provide a voice for the CAP pilot. The digitized speech equipment will be used to provide voices for the pseudo bogey and SWC models. A list of typical phrases from model vocabularies is provided in Appendix C.

Learner Controls. With the exception of the learner control options discussed in reference to the interactve teaching segments, most of the processes identified thus far are controlled by the automated instructor part of the software. The learner will have some limited controls over the pace and content of the instructional sequence. The learner will have an

abort key. Pushing the abort key instantly takes the learner out of the instruction and places him in a position to do a review of a previous segment, start his current segment over again, obtain performance and status information, or sign off the system. Finally, there is a help key available for his use. Pushing the help key will summon the human instructor. This key will allow the learner to get any of a number of different types of help he may not be getting from the training system.

SECTION III

SYSTEM REQUIREMENTS

This section identifies the hardware equipment which will be used to implement this training system. Equipment has been selected to ensure that the hardware system will be capable of performing all functions necessary to meet the software and training requirements. Most of this equipment is standard and commercially available, with published specifications. Logicon is supplying the equipment necessary to perform the special features required to adapt the commercial equipment to the training system. Peliminary specifications for the TEC, which is a new Logicon design, are given in Appendix D.

CONFIGURATION

The training system is composed of three major hardware subsystems. These subsystems are the Computer System, the Instructor Station, and the Student Station. The Computer System provides the information and computational capacity required for control of the training system. The Instructor Station gives the instructor the ability to monitor and guide the training system. The Student Station provides the instructional and evaluational interface between the student and the system. Refer to Figure 6.
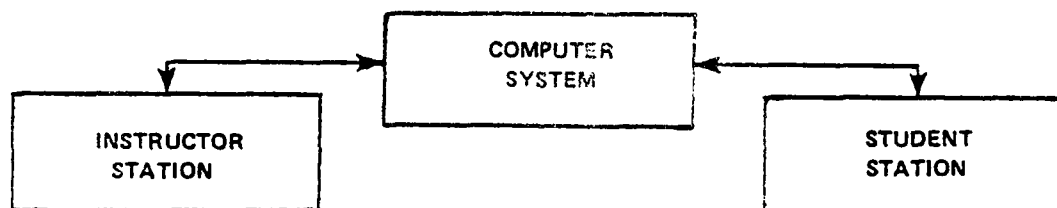

Figure 6. Training System Hardware Subsystems

HARDWARE

Definitions of the equipment in each subsystem follow.

COMPUTER SYSTEM. Major components of this subsystem are the Instructor, Simulation, and Speech computers. Refer to Figure 7. Communication between all three computers is via a Multiprocessor Communications Adapter (MCA) bus. Only the Instructor Computer communicates with elements of the Instructor Station. All three computers communicate with elements of the Student Station. The equipment for the Computer System is listed by associated computer.
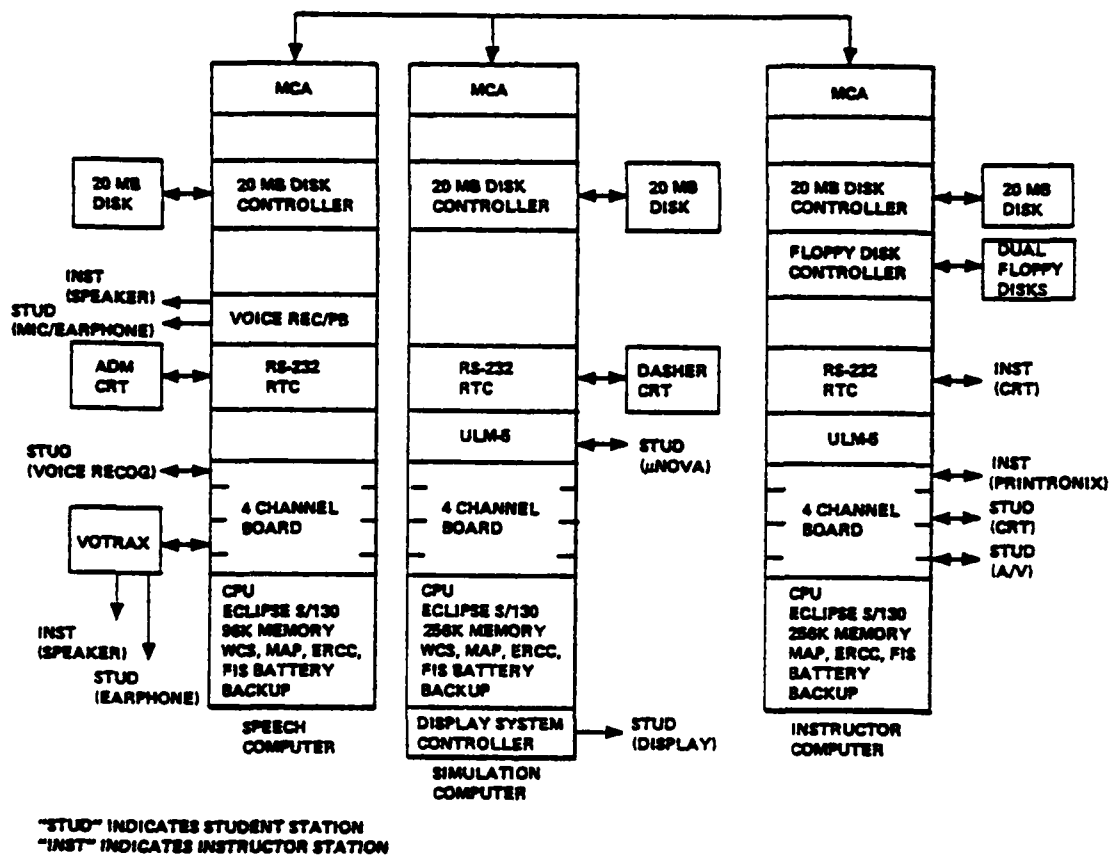
"STUD" INDICATES STUDENT STATION
"INST" INDICATES INSTRUCTOR STATION

Figure 7. Computer System Components

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Instructor Computer Equipment List. Data General Equipment:

8611-P	Eclipse S/130 computer with 256K MOS memory, memory allocation and protection unit (MAP), battery backup and automatic error checking and correction (ERCC)
8613	FIS (Floating Point Instruction Set)
8537	Expansion chassis and cable to main chassis
4206	MCA
1106-BB	MCA cable
6070	20MB disc subsystem including 6070 20MB disc drive, cables and controller board
6030	Dual diskette subsystem including diskette drive, cable and controller board
4075, 4077 4078, 4079	I/O interface subassembly including TTY, RS-232 and Real Time Clock (RTC)
4241	ULM/5 four line asynchronous multiplexer
1012P	Two single bay cabinets. One bay contains the CPU and expansion chassis and the other bay contains two 6070 drives and the 6030 drive

Logicon Equipment:

4 Channel Board. Four independent serial RS-232 I/O ports

Simulation Computer Equipment List. Data General Equipment:

8611P	Eclipse S/130 computer with 256K MOS memory, MAP, battery backup and ERCC
8613	FIS
8615	Writable Control Stores (WCS)
8537	Expansion chassis and cable
4206	MCA
1106-BB	MCA cable
6070	20MB disc subsystem, includes 6070 20MB disc drive, controller board and cable
4075, 4077 4078, 4079	I/O interface subassembly including TTY, RS-232 and RTC
4241	ULM/5
1012P	Single bay cabinet
6053-AA	Dasher Display Terminal

Logicon Equipment:

4 Channel Board. Four independent serial RS-232 I/O parts

Megatek Equipment:

Series 7000; Graphic Display Controller

Speech Computer Equipment List. Data General Equipment:

8611-M	Eclipse S/130 computer with 96K MOS memory, MAP, battery backup and ERCC
8613	FIS
8615	WCS
8537	Expansion chassis and cable
4206	MCA
6070	20MB disc subsystem including a 20MB drive, controller board and cable
4075, 4077	
4078, 4079	I/O interface subassembly including TTY, RS-232 and RTC
1012P	Single Bay Cabinet
ADM-3	Display Terminal

Logicon Equipment:

4 Channel Board. Four independent serial RS-232 I/O parts
Digital Voice Board. Analog to digital and digital to analog conversion of speech for storage and replay

Votrax Equipment:

VS-6	Voice generation unit.

INSTRUCTOR STATION. The Instructor Station is composed of a CRT terminal and a line printer connected to the Instructor computer, and an intercom for communication with the Student Station. Refer to Figure 8. Following is the equipment list for the Instructor Station.

Data General Equipment:

6053-AA	Dasher Display Terminal

Printronix Equipment:

P300	Line Printer

Logicon Equipment:

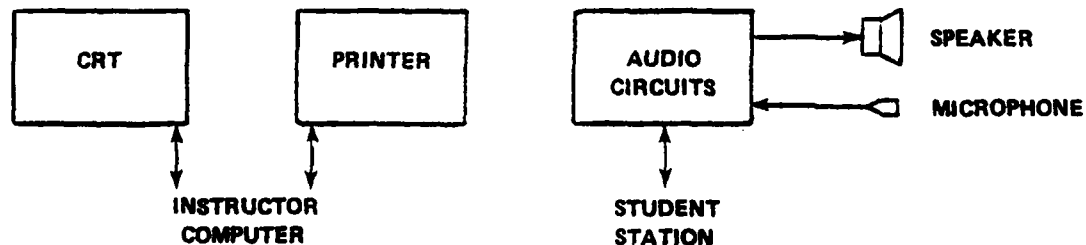Audio circuits including instructor's speaker and microphone

Figure 8. Instructor Station

STUDENT STATION. The main element of the Student Station is the Training Enhancement Console. Other elements are a CRT terminal and an audio visual system. Refer to Figure 9. The TEC communicates with both the Simulation and the Speech computers. The following is the equipment list for the Student Station.

Data General Equipment:

6053-AA	Dasher Display Terminal
8560	Micro Nova Computer with 16K memory, RTC, RS-232, down line load, digital I/O, and A to D converter

MCA Equipment:

P-7820   Video Disc Player

Sony Equipment:

CVM-1250   12-inch Color Monitor

Megatek Equipment:

Series 7000. Graphics Display Monitor

NEC Equipment:

DP-100   Voice Recognition Equipment

Logicon Equipment:

TEC panels and logic
Audio circuits
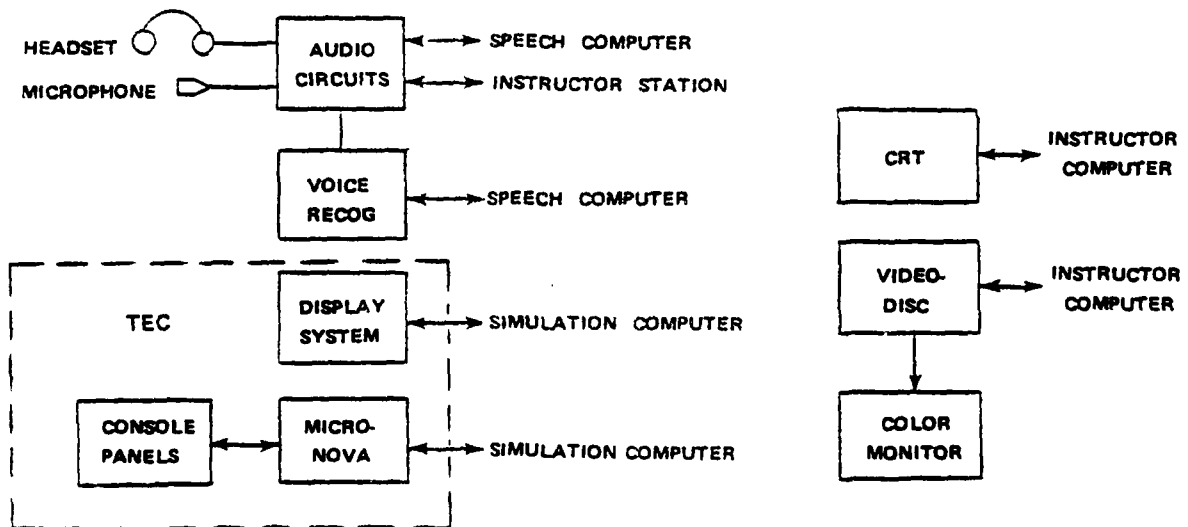
Figure 9.   Student Station

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SECTION IV

CONSTRAINTS

TRAINING SYSTEM CONSTRAINTS

Constraints are imposed on the training system as the result of hardware capabilties and software development. The discussion is divided into automated speech related constraints and general constraints.

AUTOMATED SPEECH RELATED CONSTRAINTS. The state-of-the-art in automated speech is limited. The most advanced systems have the capability to recognize only a limited number of carefully spoken words or phrases. The system must be trained to recognize the words as voiced by the speakers. The best and newest voice generation systems still have limited numbers of phonemes and inflections, usually resulting in a computer with a strong accent. These limitations imply several constraints for the training system.

Speech recognition constrains training development in three ways. First, the speech recognition hardware limits the number of words or phrases that can be trained into the system. For simulating an environment with a large amount of possible vocabulary, such as air intercept control, this means a constraint on either the breadth of instruction that can be provided or strict limitations on the vocabulary to be used. For ACE, the vocabulary has been carefully restricted.

The second constraint affecting ACE is the necessity for training the speech recognition system to understand each phrase uttered by each learner. This requirement has meant that the curriculum must integrate special voice training with the AIC skills training and has required a special orientation throughout the curriculum, reflecting the necessity to train each new word or phrase as it is encountered.

The third constraint is the requirement for providing special response and review capabilities in the system since speech recognition is not always one hundred percent accurate. The special review capability is provided by replay of the student's voice calls during instruction. It is provided as a means for determining if student performance measurement has been adversely affected by misrecognition. If it is determined that the system is misrecognizing the learner, the special response capabilty provides a retraining function for updating or correcting the learner's voice reference patterns. This area represents constraints for training, primarily because of the problems with learner confidence if the system is misrecognizing him, and also the additional time required for retraining the system on words the learner has already been through.

Votrax and digitized speech also present constraints on training design. The major problems with Votrax are that it (1) doesn't sound "human" and (2) can be hard to understand. These problems are the result of limited numbers of phonemes and inflections available. To overcome these problems requires careful tuning of Votrax phrases, special training of the learner, and special motivational designs. The design involved takes valuable time away from the development of the courseware, and the special training is not obviously relevant to the learner's perceived goal of becoming an AIC.

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Digitized speech for use in ACE training also has two constraints. First, the speech playback has relatively low fidelity; second, there is only limited room available for digitized speech. Thus, the possibility of using digitized speech to support Votrax and the audiovisual presentation system during instruction is somewhat limited.

GENERAL CONSTRAINTS. The first general constraint may be considered somewhat obvious, but it should be explicitly mentioned. As in all contracted training system development, the development of the AIC prototype training system has only a limited amount of contracted time, money, and government furnished equipment (GFE) resources available. This means training system development will be constrained to produce a system within the limits of the resources. In turn, it may not be possible to implement some training system concepts which can be designed.

The next constraint is a system constraint, involving both hardware and software. This constraint is the limited realism of the simulated radar display. Both the hardware (e.g., the Megatek display) and the software (e.g., the simulation subsystem) limit the realism of the display. Although many of the display capabilities are simulated, there will be no radar picture noise provided. This may affect the generalizability of the ACE training to the real world environment where radar picture noise is a large problem.

There are two other hardware constraints on training design. First, the simulated console has a slightly different look and feel than the console it is emulating. This, like the radar picture, can have an effect on the transfer of training to the real world. Second, the lack of a hardcopy printer at the student's station limits the type of feedback and printed support material which can be made readily available to the learner. The CRT display can present performance measurement feedback, but the display capacity is limited to twenty-four lines of text.

The last two constraints on training design are software generated. First, by design, the performance measurement system will not be operating on a real time basis during free practice. This is so the learner has the opportunity to correct his mistakes, but also means that any critical mistakes the learner makes during the run will not be noted until the end of the run. Second, the software is assuming a non-devious user. This means that there is no system being programmed in to keep the learner from cheating or trying to beat the system. For training, this means that a devious or malicious user may be able to alter training results (e.g., signing on someone else's file and altering the contents).

TRAINING CONSTRAINTS

This area discusses the constraints imposed on training by real life factors. These factors include scheduling, personnel, and training design considerations.

SCHEDULING. The AIC school has a fairly carefully worked out schedule which allows them to get their AIC candidates through the academic, synthetic, and live portions of their training regimen in six weeks. This includes nine

days of academics, twelve days of synthetic or mock-up training, and three weeks of controlling live flights under an instructor's supervision.

The ACE system curriculum has been set up to be a three week course of combined academics and synthetic training. The school, however, has requested that all students going on ACE go through their academic program (nine days) before coming onto ACE and then come off ACE two days early for any training required before controlling live flights. This leaves ACE with only ten actual days of instruction, instead of fifteen.

PERSONNEL. There are two different personnel problems which have potentially constrained training. One is the availability of instructors, and the other is the capability of the students.

The instructors on the AIC School staff are already very busy. The addition of the ACE system to their responsibilities has created a new burden. Although the people at the school have been most helpful in working out personnel assignments, there is no way to tell what effect the extra burden is having on the attitudes of the staff toward the training system. It is well proven that negative attitudes held by instructors can seriously damage the effectiveness of any training system.

The students being sent to the AIC School recently have apparently been substandard in their preparation for the school. Indeed, in the last two quarters of 1980, the AIC school had an extremely high failure rate. The exact effect of this problem on the success rate of ACE probably will not become apparent. However, it seems safe to say that students who could not make it through the regular curriculum might have trouble with the ACE curriculum as well.

TRAINING DESIGN. There are three different sources of constraints in the area of training design. These have to do with the nature of the present training approach, changes in the AIC School syllabus over the last two years, and the changing nature of the NTDS program itself.

At some time in the past an official AIC School policy was set which decreed new students would only be taught how to handle aircrew training flights. Therefore, although the academic portion of the curriculum considered many tactical concerns, the AIC students only encountered training setups during their synthetic and live flight control training.

In order to train tactical skills, as defined as part of the AIC's job, it is necessary to develop brand new instructional objectives and materials. These materials are incorporated into the ACE system curriculum. However, these new materials allow even less time for the student to learn the taining setup skills focussed on and required by the school.

Moreover, Logicon is chartered to recreate the AIC School syllabus on the ACE system. During the two years that Logicon has been working on this project, the AIC School syllabus has undergone one major revision and several minor revisions. If Logicon had stuck to the original syllabus, the ACE curriculum would have been hopelessly out of date and out of step. The changes required, to keep current, use valuable resources that can be used elsewhere in the training design process.

Additionally, the decision was made, also for the sake of currentness, to emulate the latest NTDS program. This meant having to design instruction for a program that had not yet been tested. In addition, some of the NTDS program functions were redefined during the Navy's development process. Updating the courseware to parallel ongoing NTDS program changes depletes valuable resources.

SOFTWARE CONSTRAINTS AND CONVENTIONS

The most modern, state-of-the-art concepts are being used in the design and development of ACE software. Design and coding of this extremely complex system will be done in a structured, top down fashion. Structured programming and design techniques result in simple and "clear" software that is quickly developed, easily understood, and comparatively easily checked out.

Discussions follow of some of the programming tools to be used in the development of ACE and some of the advantages and possible constraints of these tools.

STANDARD SYSTEM SOFTWARE. ACE will take full advantage of the basic software packages provided as part of the GFE, using editors, compilers, and the basic operating system provided by Data General. The great advantage of doing this is that these very useful tools are already available and fairly well checked out. There are two major disadvantages in using this software. One is that the vendor continues to develop and "improve" its software, releasing revisions which cause the baseline software to change. If revisions are not made to the basic ACE software package, the vendor may refuse to address problems uncovered in that package. On the other hand, many of the revisions bring changes in performance or new problems which may seriously adversely affect the ACE program. The vendor software on the ACE system will be revised, to be consistent with standard vendor software, until the time that making such revisions would hinder development of the ACE software package.

The second major disadvantage of the vendor supplied software is that it is intended to support many different applications, as opposed to the very special applications required for ACE. Consequently, it will not perform all functions required by ACE, nor will it always perform functions as efficiently or thoroughly as ACE requires. Therefore, special purpose software sections will be written for ACE, and any necessary modifications will be made to supplement the basic vendor software.

PROGRAM DESIGN LANGUAGE (PDL). PDL is a design tool which will be used in ACE to support the design effort. A design written in PDL is written in structured English and includes control information that creates a nicely formatted and organized design document from which programs can be coded. The source input for PDL exists as a disk file which may be created and updated using the text editors. Use of PDL will standardize the format of design documents.

PDL has few a disadvantages. It supports only text. If graphic pictures are needed to specify a design, they may be cross referenced to the design document. There is a minimal charge applied to each use of PDL. Using PDL consumes computer resources, which also cost money. Finally, in

common with all design tools and techniques, design files must be updated as changes are made, or the design will not match the state of the program.

PROGRAMMING LANGUAGES. ACE software will be written in Data General (DGL), FORTRAN 5, or, if necessary, assembly language. A software module will be written in assembly language ony if the task the module must perform could not be achieved if the module were written in one of the higher level languages.

DGL is a Data General ALGOL. It provides a control structure which facilitates writing structured programs. DGL will be the preferred language.

In general, high level languages are less efficient than assembly languages because the code generated by compilers must handle general cases, while assembly language can be exactly tailored to the problem at hand. The DGL and FORTRAN compiler used by ACE generates efficient code in most situations. Programming techniques which further this optimization will be used whenever possible.

TRAINING FUNCTIONS DEFINITION LANGUAGE. ACE will provide some form of a "training language" to facilitate definition of courseware and scenarios.

COMPLEX SYSTEMS DEVELOPMENT. The ACE program will require fully integrated support and functioning of a large number (five or more) of independent processing systems. The software will support a multitude of functions including such diverse capabilities as detailed performance measurement, speech recognition, instructor and trainee feedback and control mechanisms, environment simulation, and system evaluation. The software system needed to support these functions will be complex. In so complex a system, errors will creep in and some will be difficult to find. To alleviate this problem, the system will be explicitly and clearly defined. The structured design and programming techniques discussed earlier will be fully utilized. A modular plan of integration will be carefully defined and followed. Finally, state- of-the-art debugging tools and techniques will be used to help trace and identify any errors that persist.

HARDWARE CONSTRAINTS

This system is subject to the normal computer hardware constraints such as: a controlled temperature and humidity environment, a minimum of static electricity, an electrical power source with a minimum amount of electrical noise, physical placement limitations due to floor loading and cable lengths, planned down time for periodic maintenance, and unplanned down time due to component failure. More detailed information concerning these limitations will be provided in the Prototype Facilities Report.

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APPENDIX A

BASIC TRAINING TOPICS

MUST KNOW

The AIC cannot perform live air control at the Fleet Combat Training Center, Pacific, even under supervision without these basic skills:

Set up UYA-4/V10 for ease of reading dials and normal operations

Detach the wingman for separation

Vector the bogey for "pseudo" intercepts

Enter CAP symbol into NTDS

Locate assigned aircraft (A/C)

Determine the:
a) bogey's heading
b) CAP heading
c) Target aspect angle

Establish communications

Keep the A/C on the scope

Detect bogey appearance

Provide headings to remain within the area of 5 miles prior to penetration of boundary

Report bogeys/hostiles A/C

Transmit magnetic bearing and range from CAP to bogey

Respond to contact/lost contact calls

Respond to Judy/Tally Ho/Visual Calls

Transmit bogey altitude information

Detect/report bogey jinks direction

Recommend a heading for an NCI

Update track after a jink

Update the state and weapon status into the NTDS system

Transmit revised heading to counter jink

Track A/C symbol to ensure the symbol is on video

Transmit breakaway headings to CAP

Recognize/report priority threat

Update the CAPs heading

Maintain track of all aircraft

Report friendlies and strangers A/C

Monitor A/C fuel state and weapon status:
a) when reporting on station
b) on station
c) after each intercept

Respond to "visual" on other A/C

Estimate magnetic bearing and range without NTDS

Determine lost communications protocol

Transmit "in the dark" calls

Transmit bogey splits

Respond to request for bogey dope on other A/C

Select desired bank angle

Estimate track and ground speed without NTDS

NEED TO KNOW

The AIC needs these skills in order to perform live air control at the Fleet Combat Training Center, Pacific, without supervision.

Transmit headings for rendezvous

Transmit bearing and range to joining A/C

Relay altitude of A/C to joining A/C

Transmit turn to facilitate rendezvous

Plot position of crash or bailout

During emergency, maintain track or position

During an emergency, provide bearing and range information to homeplate

During an emergency, provide headings to homeplate

IMPORTANT TO KNOW

The AIC cannot perform live air control in a tactical environment without these skills:

Vector A/C to station

Disengage the CAP symbol from station

Assign the CAP to station

Notify the SWC of the engagement

Notify the SWC of the results of the engagement

Notify SWC of breakaway

Relay orders from the SWC to A/C

Inform the SWC when probability of intercept is poor

Notify the SWC the CAP is on station

Inform the SWC of splitting bogeys

Inform the SWC of state and status

Notify SWC of bogey appearances

Notify SWC A/C assigned as an additional weapon

Relay engagement orders to the A/C

Keep CAP on station until an engagement order is received

During an emergency, notify SWC

APPENDIX B

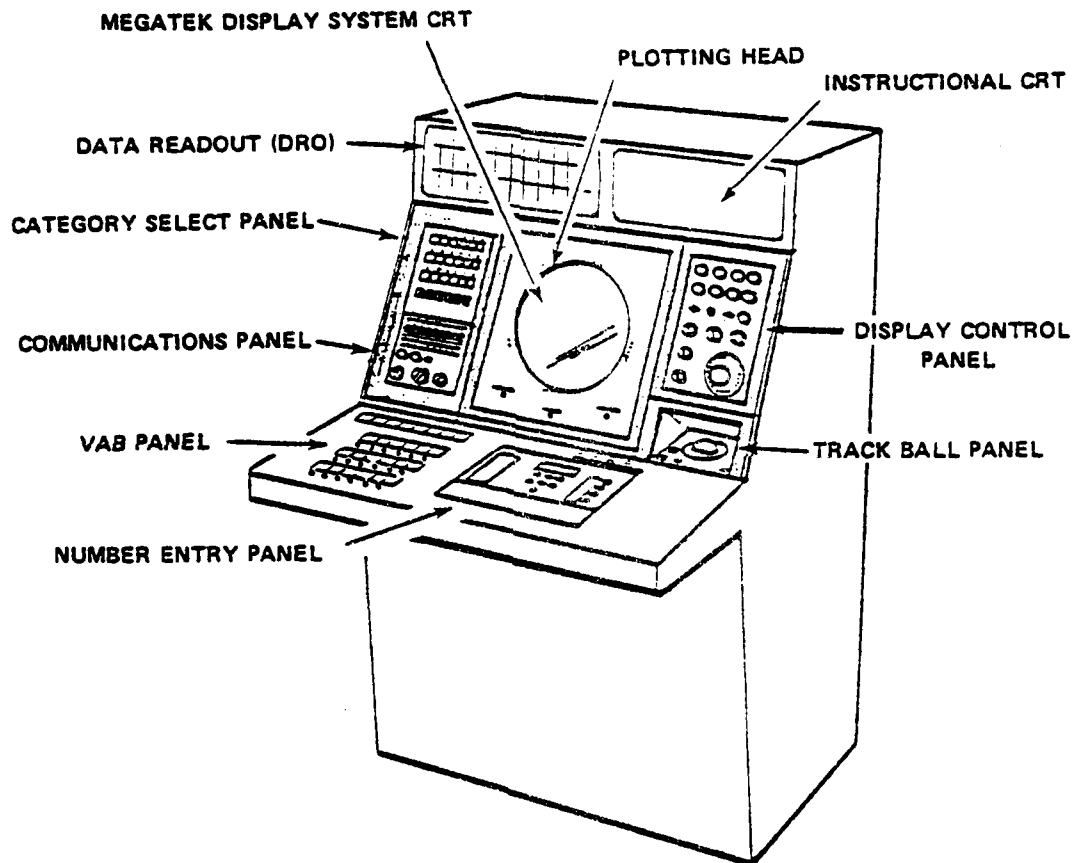PROPOSED TRAINING ENHANCEMENT CONSOLE (TEC) PANEL LAYOUTS
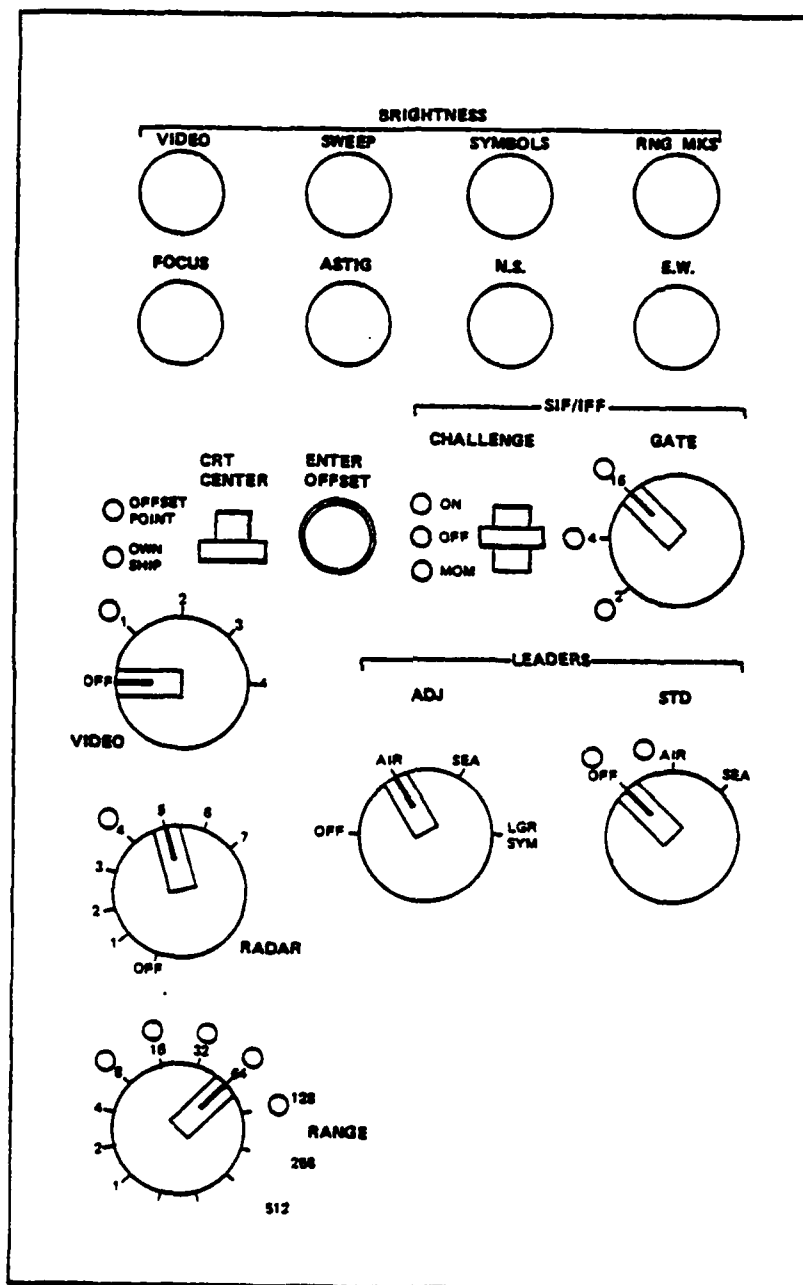

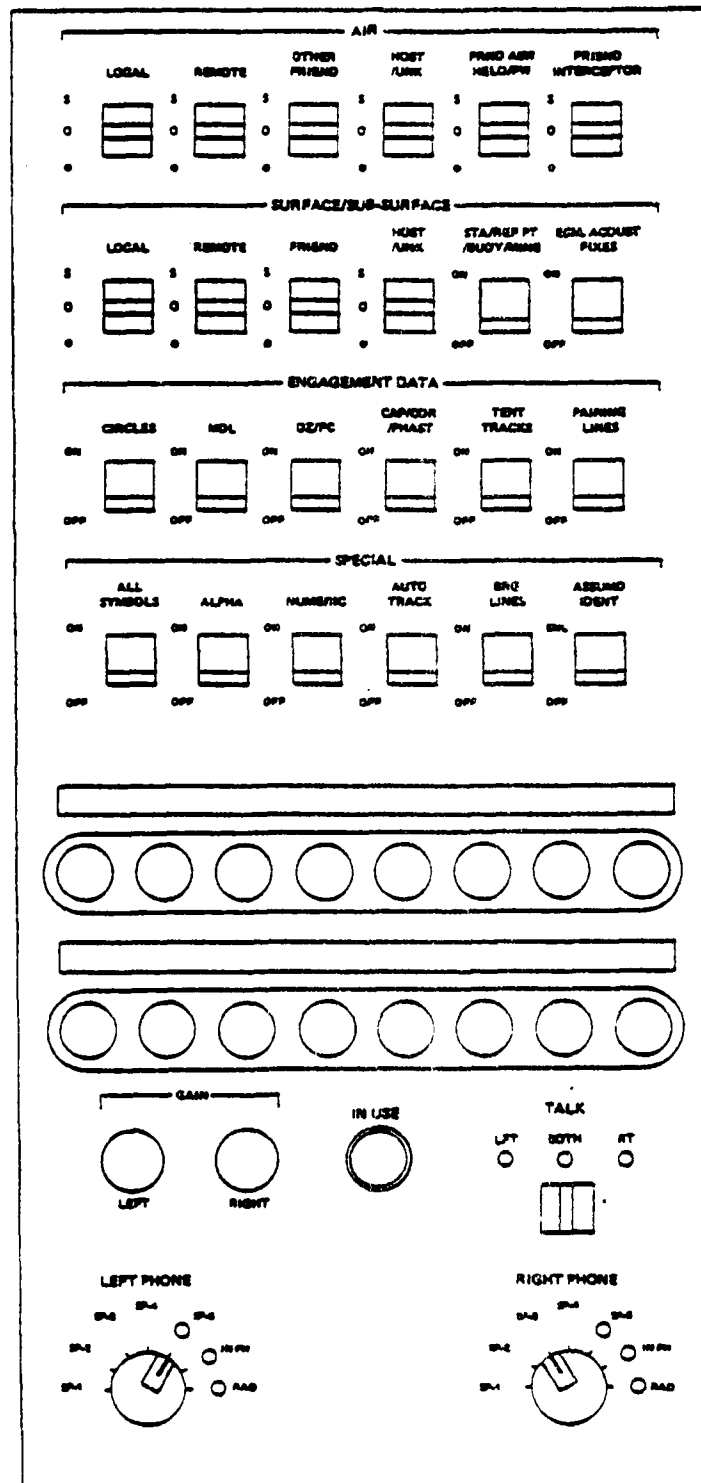Figure B1. Training Enhancement Console

Figure B2. Display Control Panel

Figure B3. Category and Intercomm Select Panel

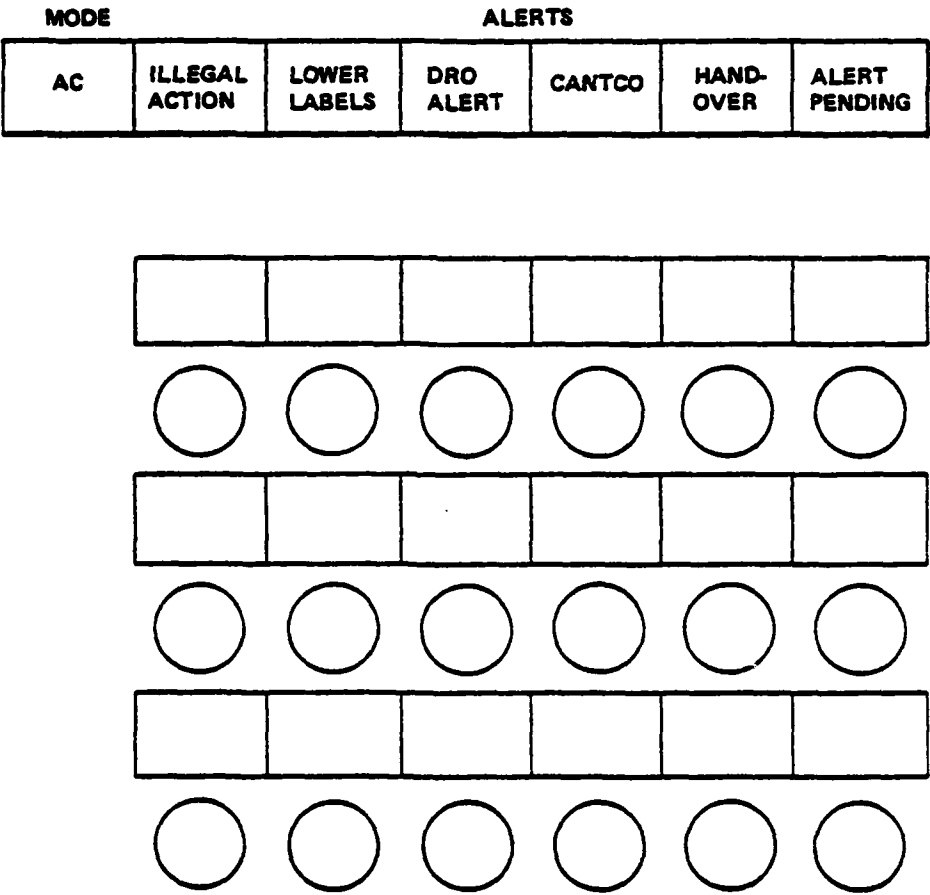| MODE	ALERTS					
AC	ILLEGAL ACTION	LOWER LABELS	DRO ALERT	CANTCO	HAND-OVER	ALERT PENDING

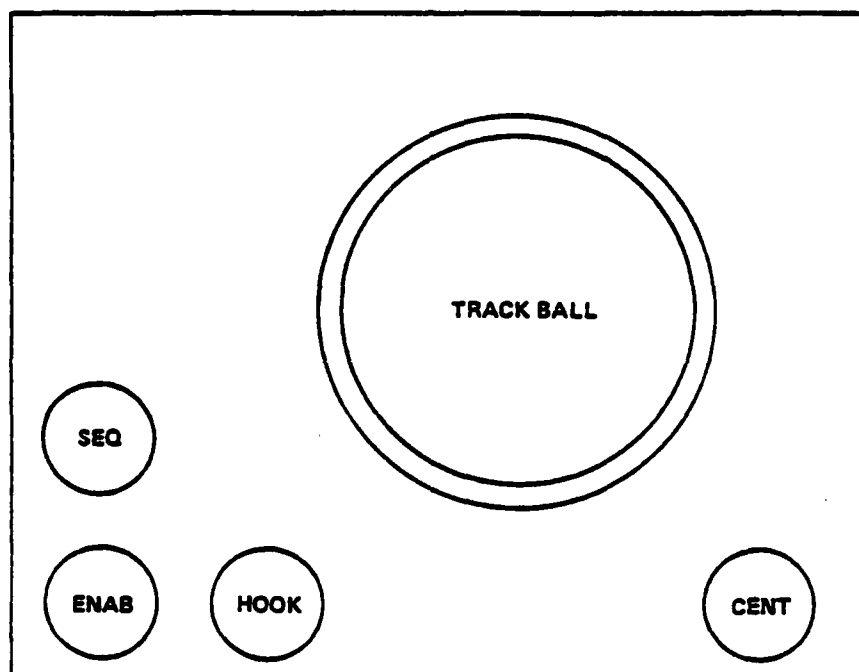Figure B4.   Variable Action Button (VAB) Panel
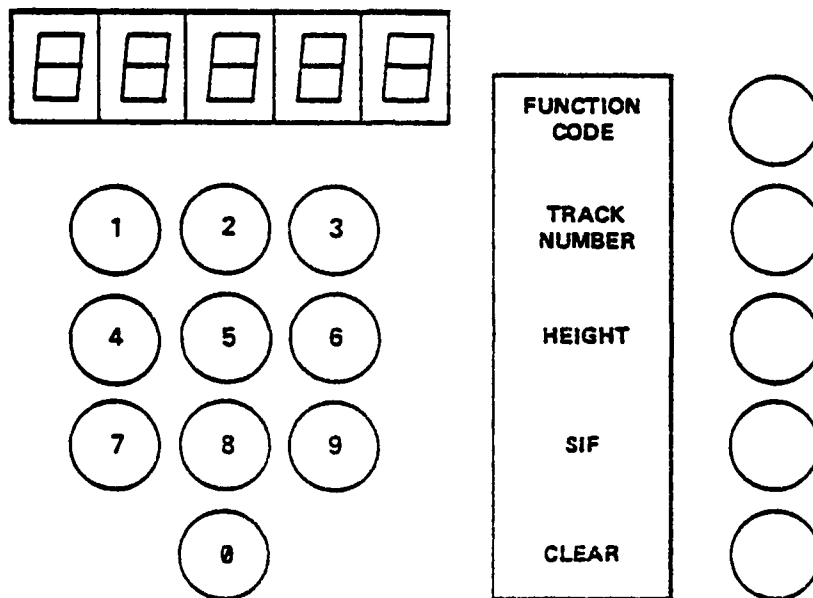
Figure B5.   Number Entry Panel

Figure B6. Track Ball Panel

APPENDIX C

SWC AND CAP MODEL PHRASES

VERBALIZATION FROM SWC MODEL

What state
Update symbols
Results of intercept
Thank you
Say again
C/S airborne for control
SWC aye
Very well
Breaking report
State location

VERBALIZATION FROM CAP MODEL

Ruth this is C/S on Miramar's (TACAN bearing, range) - (C/S)
    Angels (altitude)
    Heading (XXX), over
C/S, Roger looking
C/S visual
Contact (bearing, range)

Judy
Tally Ho
Fox 1
Splash (1) bogey
Rendezvous point (rendezvous point), Angels (ZZ-altitude)
Roger XXX
Breakaway
State ----- (3 digits for fuel)
Lost contact
Roger, stranger opening
Roger, ease turn
Roger, tighten turn
(XXX-bearing), (YY- range) (in response to TACAN request)
Request rendezvous with C/S
Roger, C/S (port/starboard/vector) (hard) (XXX-directed heading)
    for station
Famished
Bogey dope on platform
Heads up (no.) bogey(s)
Roger
Request bogey dope on platform
Request breakaway heading

Say again

Additionally:

The A/C will repeat all headings orders

The A/C will Roger all transmission ending in over that are not
heading orders

VERBALIZATION FROM PSEUDO BOGEY MODEL

Roger
Roger (XXX-directed heading)
State (3 digits for fuel)
Roger, ease turn
Roger, tighten turn
(XXX-bearing), (YY-range) (in response to TACAN request)
Say again

APPENDIX D

TRAINING ENHANCEMENT CONSOLE (TEC)
DESIGN SPECIFICATION FOR PANELS

This paper is intended to describe the basic TEC excluding the display system and the computer interface. The NTDS console emulated will be the UYA-4/V10. The functions described herein are considered to be the basic functions needed by the prototype AIC training system. Deleted or limited functions may actually be provided but are not considered basic.

Sampling of the position/actuation of all controls, buttons, switches, lights, etc., will be done by the micro-Nova. Implementation of the function of each control, etc., will be determined by software in the Simulation Computer. It is intended that the micro-Nova perform all the housekeeping chores associated with the console and communicate with the Simulation Computer with formatted messages on an as-needed basis.

TEC controls by functional groupings:

1. Communications Panel/Footswitch/Headset

2. VAB Panel/Buzzer

3. Display Control Panel

4. Trackball and Controls

5. FABs

6. Category Select Panel

7. Number Entry Dial (NED) Panel

8. Plotting Head

9. DRO

Functional Description of each group:

1. <u>Communications</u> - A headset with microphone and earpiece will be provided that will allow two mixed voices to be heard. The earphone will be capable of listening to two sources: NTDS inter-console communications (SWC) and one radio channel. A footswitch will be provided for transmission, and a radio-in-use light will be provided.

2. <u>Variable Action Button (VAB) Panel</u> - Eighteen (18) quick action buttons (QAB) with readouts for the AC mode (Model 4.0.1) will be provided. Also provided will be six (6) individually selectable alert readouts and a buzzer, plus a "beeper on ground" signal.

3. <u>Display Control Panel</u> - Controls will be provided to individually control the brightness of the video, sweep, symbols and range marks.

Three (3) ranges will be selectable: 16, 32, 64. Also included is offset control.

4. <u>Trackball</u> - A trackball for moving the ball tab symbol will be provided. Also included will be ball-tab center, ball-tab enable, hook and sequence switches.

5. <u>Fixed Action Buttons (FAB)</u> - The only FABs provided will be Drop Track and Enter Mode and Radar. (By strict definition, those switches associated will the ball-tab are also FABs.)

6. <u>Category Select Panel</u> - This panel will not be implemented.

7. <u>NED Panel</u> - Provided will be a ten key keypad and five digit readout for entering general purpose function code, track number, height, and SIF.

8. <u>Plotting Head</u> - A plotting head from an actual console will be used.

9. <u>DRO</u> - The DRO will be implemented using a CRT monitor mounted at the top of the console.

Following is a detailed description of all controls to be implemented (and to be deleted) in each functional grouping. Setup of all controls that are deleted or not implemented will be addressed in the audio/visual presentations.

1. <u>Comm Panel</u>

    1.1 Interconsole stations - One station will be implemented: SWC (this is the second button in top row). The other 14 switches will be deleted. The lighted pushbutton switch is alternate-action. Depressing the switch will light the button and indicate the operator's desire to communicate with the indicated console. If an unlighted button begins to blink at a 2 Hertz rate, the console operator is thereby notified that the indicated desires to talk to him. In order for inter-console comms to take place, the operator must then press the indicated button, whereupon the light will be steady. In addition, the first button in the top row will be implemented as the standard pointer button.

    1.2 Radio - Only one radio channel is to be used, thus the channel selector knob will be deleted.

    1.3 Left Phone Switch - A seven position rotary switch will be implemented. The position of this switch determines one source of the audio heard in the earphone. There will be LED pointers at 3 positions. Sound powered 1 thru 5 are dead air positions.

    1.4 Position Right Phone Switch - Same as Left Phone Switch.

1.5 Left/Right/Both Talk Switch - 3 position toggle switch - Determines destination of operator's voice. If in Left position, transmission will be directed to whomever the Left Phone Switch is set. Likewise for Right and Both. There will be LED pointers at each position.

1.6 Gain Controls - Not implemented.

1.7 Radio in Use Light - A red light to indicate that the footswitch is depressed.

1.8 Footswitch - This switch will indicate the start and end of transmission by the operator either on the radio or the interphone circuit.

1.9 Headset - A headset with microphone and earpiece will be provided.

1.10 The panel will be back-lit to illuminate all switch nomenclature.

2. VAB Panel

2.1 Quick Action Buttons (QABs) - 18 lightable, pushbutton switches will be used. Legends for AC mode split labels as defined in the SOM for 4.0.1 are provided. Switch lights will be under program control.

2.2 Alerts - 6 program selectable alert readouts will be provided.

2.3 Buzzer - When the appropriate alerts are generated by the Environmental Computer, the computer will also activate the console buzzer at a 2 Hertz rate.

3. Display Control Panel

3.1 Brightness Controls - Potentiometers will provide inputs to the micro-Nova which will then send to the display system the proper signals to control individually the brightness of the video, the sweep, the symbols and the range marks.

3.2 CRT Controls - Not implemented.

3.3 Range Switch - The rotary range switch will have 3 active positions: 16, 32 and 64 miles. All other positions will be deleted. There will be an LED pointer for each switch position.

3.4 CRT Center Switch - 2 position toggle switch: Offset Point and Ownship. In Ownship position, ownship will be the center of the CRT. In Offset Point the computer will instruct the display system to offset the entire display to the position

of the balltab. There will be an LED pointer for each switch position.

3.5 Enter Offset - A lighted pushbutton switch that instructs the computer to update the offset point to the current position of the ball tab.

3.6 SIF/IFF Gate - Not implemented.

3.7 SIF/IFF Challenge - Not implemented.

3.8 RADAR - Position "4" is the only active position. If not in this position, there is no sweep. An LED is provided at Position 4.

3.9 VIDEO - Position "1" is the only active position. If not in this position, there is no video. An LED is provided at Position 1.

3.10 LEADERS - These 2 switches are deleted - Air Standard leaders is the only position. If not in this position, there are no leaders. LEDs are provided for the "OFF" and "AIR" positions.

3.11 TTG DIAL - Deleted

3.12 The panel will be back-lit to illuminate all switch nomenclature.

4. Trackball and Controls

4.1 Trackball - A 3-1/2 inch trackball will be provided.

4.2 B/T Center - Ball Tab Center switch - lighted pushbutton - light will be under computer control to act as a pointer.

4.3 B/T Enable - Lighted pushbutton switch for ball tab enable - light will be under compute control to act as a pointer.

4.4 Hook - Lighted pushbutton switch - light will be under computer control to act as a pointer.

4.5 Sequence - Lighted pushbutton switch - light will be under compute control to act as a pointer.

5. FABs

5.1 Drop Track - Pushbutton switch.

5.2 Enter Mode and Radar - Pushbutton switch.

6. Category Select Panel - deleted

7. **NED Panel**

   7.1 Keypad - A ten key keypad with lighted legend keycaps will be provided allowing entry of numbers.

   7.2 Readouts - 5 decimal LED readouts will be provided to display the numbers entered at the keypad.

   7.3 Function Code - Lighted keycap pushbutton for entry of General Purpose Function Codes. The light will be under computer control to act as a pointer.

   7.4 Track Number - Lighted keycap pushbutton for entry/callup of track number. The light will be under computer control to act as a pointer.

   7.5 Height - Lighted keycap pushbutton for entry of height. The light will be under computer control to act as a pointer.

   7.6 SIF - Lighted keycap pushbutton for entry of SIF code. The light will be under computer control to act as a pointer.

   7.7 Clear - Lighted keycap pushbutton for cleaning NED readouts. The light will be under computer control to act as a pointer.

8. **Plotting Head** - Actual plotting head for use in casualty mode. Requires no software functions.

9. **DRO** - A CRT will be provided to display 36 readout positions. They will be formatted in a 6 by 6 array.

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